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Non-invasion sensing of glucose levels in human blood plasma by ultrasonic measurements

S. Nagaveni[1], Ajay Vasishth[2], T.Radha Krishna[3]

[1]Department of Physics, St.Peter's Engineering College, Hyderabad, India.
[2]Department of Applied Sciences, Physics group, Chandigarh University, Punjab, India.
[3]Retd. Department of Physics, J. N. T. University, Hyderabad, India.

Abstract: This paper intends to integrate the current information about that data on Acoustic and Elastic parameters of Plasma of Normal Human blood. The parameters such as the ultrasonic velocity, Absorption coefficient, Modulus of elasticity and Loss modulus were calculated and tabulated for normal and diabetic mellitus of plasma its constituents at different frequency ranges. This paper reveals that tabulated data on specific gravity of plasma, water, erythrocytes of human blood. In the present investigation generally maximum velocity of blood is meant by velocity of blood is streaming in the capillary tube having infinite length is sustained from the graph. The capillary viscometry is the most prescribed method for evaluating the viscosity in liquids .In Human Physiology we are fascinated with specific characteristics and distinctive mechanisms of human body that make it a living being. So human being is actually automation and it is a part of automatic sequence of life, these special attributes allow us. In diabetic mellitus there is sufficient evidence that the elevated blood viscosity is a pathaogenetic factor of diabetic microangiopathy, altering microcirculation and leading to insufficient tissue nutrition. This paper mainly keen observation of that tabulated the data on ultrasonic velocity in different constituents of noramal and diseased blood. Generally blood sample is centrifuged and separated the plasma in this specific gravity was found for the five samples and it furnishes very good agreement with the standard values. This study is essential and developed in Biological and pathological division.

Key words: Erythrocytes, Diabetic mellitus of plasma, specific gravity, Absorption coefficient, Ultrasonic Interferometer.

Introduction:

Viscosity of human blood is very substantial for healthy functioning of heart and blood vessels. In human body Blood plasma is the very crucial, unrecognized and largest component of your blood. It is a yellowish liquid component of blood, makes up 55% of its total blood of the volume along with water, plasma carries salts and enzymes. The Bio physics of blood flow in micro vessels has been studied in various modules those are implicating in vivo and vitro experimental studies. Previous reviews such as Gaehtgens [1], Chein [2], Zweifach and Lipowsky [3], Goldsmith et al. [4] and Secomb [5]. Generally Blood is a concentrated suspension of cells in plasma and mechanical interactions between blood cells and microvasculature effect the distribution of blood flow. On the Basis of circulatory motion the blood flow means simply the quantity of blood that passes through a given point in the circulation in a given period of time. The basic mechanical properties of human red

blood cells are well implanted [6, 7] and many methods to measure Whole blood and plasma viscosity have been described. In Health cases plasma plays major imperative role ,critical component in the treatment of many serious health problems are create the therapies in rare chronic conditions. With access to these treatments, people with these conditions can live long and productive lives. In fact that, some health organizations call plasma "the gift of life". In addition Red blood cells (RBCs) possess a unique capacity for undergoing cellular deformation to navigate across distinctive human microcirculation vessels, permitted them to pass through capillaries that are smaller than their diameter and to carry out their role as gas carriers between blood and tissues. Microfluidic techniques have been diagnosed in dynamic experimental models for the virtue of RBC membrane alterations in pathological conditions and the role that such alterations play in the microvasculature flow dynamics. Exclusively the specific gravity of blood is depends on its cellular and plasma protein contents. In physiologically blood volume has variation due to intrauterine life and various reasons the blood volume increases as fetus grown and birth, it steadily increases as the child grows to adulthood when normal value is reached. In the present investigation a simple capillary viscometric technique is employed, used to measure both viscosity and volume flow rate was recorded [9]. In the present investigation a simple capillary viscometric technique is employed, used to measure both viscosity and elasticity [8].

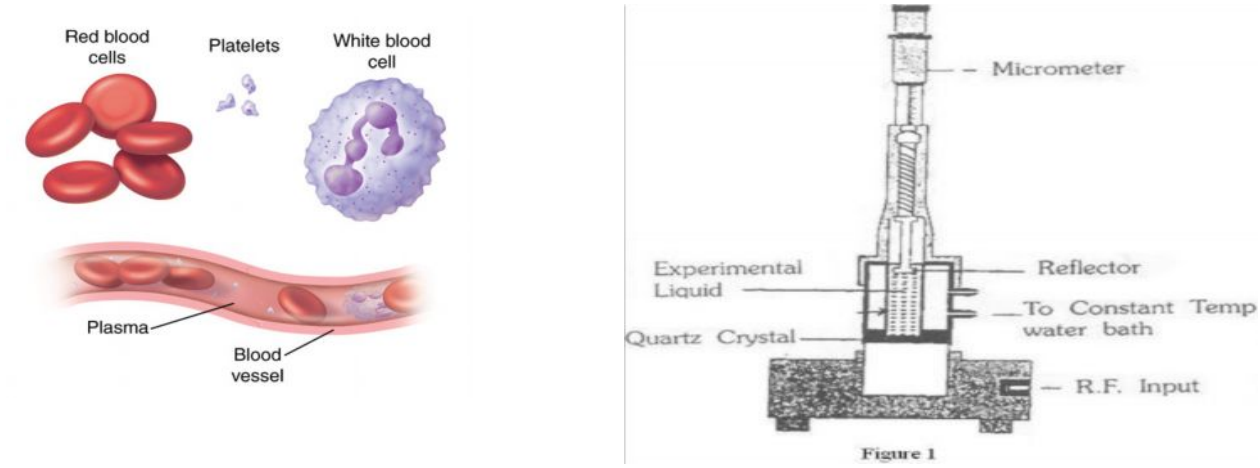


Figure 1

Ultrasonic velocity measurement:

The present paper includes a brief discussion about on various parameters in liquids are measurements of ultrasonic velocities are made in liquids in order to get idea of their physical and chemical properties Basics of ultrasonic is a branch of physics it deals with the study and applications of sound waves having frequencies ranges. A large number of such measurements have been made and given in the literature[10,11,12].One of the most important method is Ultrasonic Interferometric Technique is generally employed for the measurements ultrasonic velocity in liquids .In the present work ultrasonic velocity can be measured by an Interferometric technique method, Which is modified in the version of Owens and Simons[13].

Experimental Set up and Principle of Ultrasonic Inrferteometeric Technique for Liquids:

This is a simple device, NDT (Non Destructive Testing) device and it is very traditional, more suitable for precise absolute measurements with high degree accuracy of frequency of range is from 1 to 10 MHZ and also this can be used for solids, liquids .On the basis of this interferometer a computerized version for ultrasound absorption measurements in liquids [14].

Discription: The ultrasonic interferometer is consisting of the following two parts

a) **The High Frequency Generation**:

This is designed to exact quartz plate fixed at the bottom of the measuring cell at its resonant frequency to generate ultrasonic waves in the experimental liquid in “Measuring cell” .A Micrometer to observe the changes in current and to controls for the purpose of sensitivity regulation and initial adjustment of micrometer are provided on the high frequency generator.

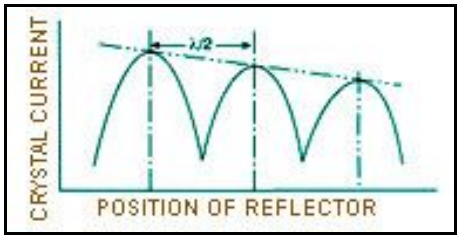
b) Measuring Cell:

This is a specially designed double walled cell for maintaining the temperature of the liquid constant during the experiment. A Fine micrometer screw has been provided at the top .which can lower or raise the reflector plate in the cell through a known distance. It has quartz plate fixed at its bottom.

The micrometer is slowly moved till the anode current meter on high frequency generator shows maximum. A number of maxima readings of anode current are passed on their number 'n' is counted. The total distance (d) thus moved by the micrometer.

Principle:

This is used in the measurement of velocity (v) is based on the exact measurement of the wavelength (λ) in the medium. Ultrasonic waves of known frequency (*f*) are generated by a quartz crystal is permanent at the bottom of the cell. These waves are reflected by a movable metallic plate kept parallel to the quartz crystal. If the distance between these two plates is exactly a whole multiple of the sound wavelength, standing waves are created in the medium. Due to acoustic resonance gives rise to an electrical reaction on the generator motivating the quartz crystal and the anode current of the generator becomes a maximum.



If the separation is now increased or decreased, and the disparity (difference) is exactly one-half wavelength (*λ/2*), or multiple of it, anode current shows maximum. From the knowledge of wavelength (*λ*) the velocity (*v*) can be obtained by the relation: Velocity (V) = wavelength (*λ*) x frequency (f). Actually interferometer interferometer is an instrument to measure the exact wavelength of any wave in motion. one of the most accurate ways of measuring ultrasonic constants in liquids or gases usually done in a column at one end of which the source is located and and the other end of which is placed a reflector is known as single interferometer, which is proposed by Perrin [15]

$V=f \times \lambda$

Materials and methods:

In Materials and Methods deals with collection and maintenance of the Blood samples. In the present Investigation simple capillary viscometric technique is employed, used to measure the both viscosity and volume flow rate. For this study the quantity of required sample is about 5 ml. In this Fresh samples of Normal Human blood are collected from Diagnostic center, Hyderabad and collected from the patients suffering from Diabetic mellitus Which is at Government Hospital at King Koti, and normal blood of volume is nearly 20 ml were collected from Maderesh Inderesh Hospital, Apollo nursing centre, Dehradun. The EDTA was used as an anticoagulant used to study Viscosity of Human blood and its constituents at the rate of 300µl for 20 ml of blood samples. The samples are collected in silicones bottles with EDTA anticoagulant in the powder form. Red blood cells of normal and diseased blood were isolated from plasma by centrifuging the blood at the rate of 1500 rpm for about 15 minutes, and then packed cells were washed in isotonic glycin-glucose solution (2.1% glycin and 5.5% glucose in the volume ratio of 9:1). When washed the packed cells were then mixed with isotonic solution. The concentration of cells was determined using a red blood cell counting chamber and spectro-colorimeter with optical density as a guide.

Data on Acoustic and Elastic Parameters of Normal Human Blood and its constituents.

Table1: A plot between Frequency on X –axis and Absorption coefficient on y axis for Diabetic plasma of human blood

Sample code	Frequency ϑ (MHZ)	Ultrasonic velocity (m/sec)	Absorption coefficient α (cm^{-1})	Modulus of elasticity($\times 10^{11}$) Dynes/ (cm^2)	Loss modulus (×10 dynes/(cm^2)
DP1	1	1544	0.065	0.024	0.125
	2	1459	0.058	0.047	1.097
	3	1482	0.052	0.019	3.824
	5	1484	0.040	0.019	42.199
	10	1920	0.027	0.018	422.559

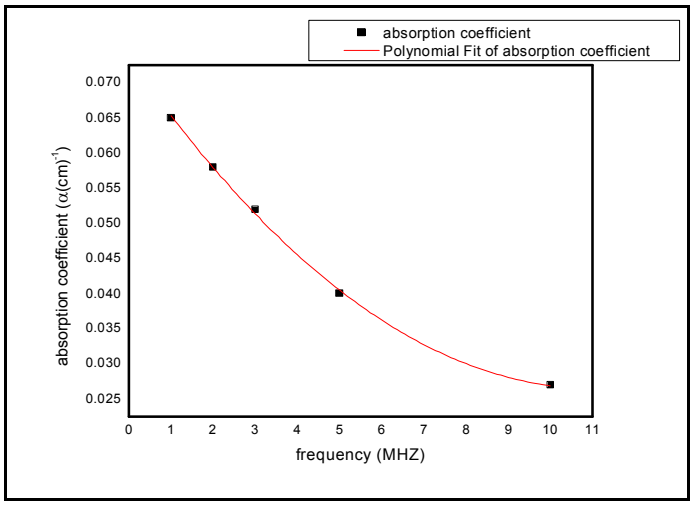
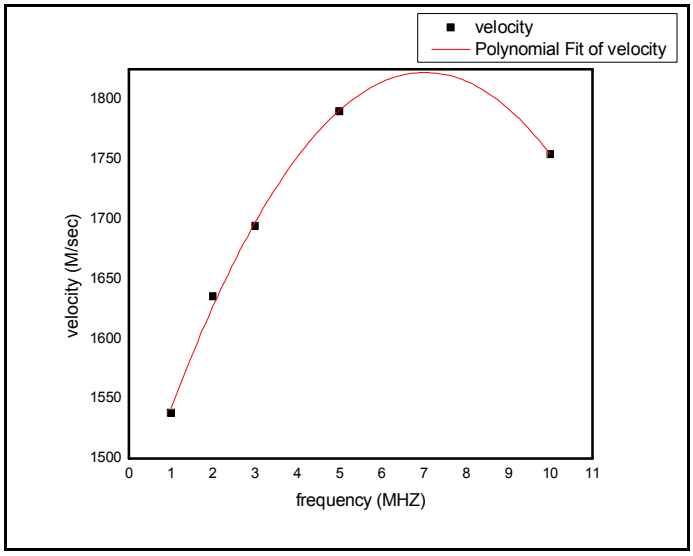


Table 2: A plot between Frequency on X –axis and Velocity on y axis for plasma of human blood

Sample code	Frequency ϑ (MHZ)	Ultrasonic velocity (m/sec)	Absorption coefficient α (cm^{-1})	Modulus of elasticity($\times 10^{11}$) Dynes/ (cm^2)	Loss modulus (×10 dynes/(cm^2)
HP1	1	1538	0.027	0.198	0.60
	2	1635	0.024	0.702	9.76
	3	1700	0.039	0.629	12.02
	5	1785	0.018	0.134	231.52
	10	1754	0.017	4.818	605.70

Table 3: Aplot between Frequency on X –axis and Velocity on y axis for plasma of human blood

Sample code	Frequency ϑ (MHZ)	Ultrasonic velocity (m/sec)	Absorption coefficient α (cm^{-1})	Modulus of elasticity ($\times 10^{11}$) Dynes/ (cm^2)	Loss modulus (×10 dynes/(cm^2)
HP2	1	1494	0.025	0.245	0.84
	2	1532	0.016	0.025	0.05
	3	1573	0.023	1.152	47.09
	5	1635	0.014	2.258	301.66
	10	1696	0.014	6.409	544.03



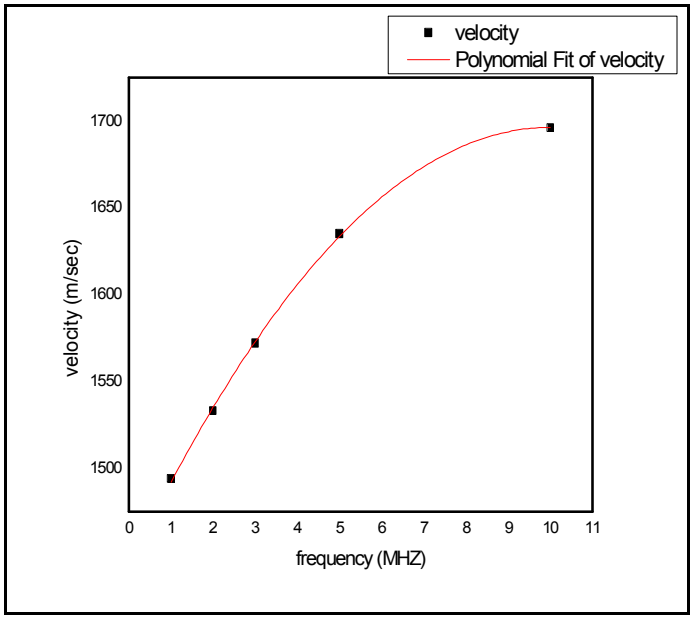
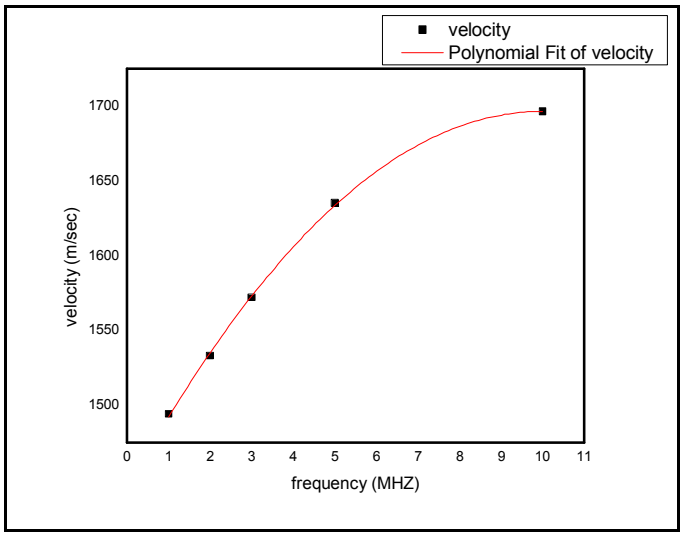


Table 4: A plot between Frequency on X –axis and Velocity on y axis for Diabetic plasma of human blood

Sample code	Frequency ϑ (MHZ)	Ultrasonic velocity(m/sec)	Absorption coefficient α (cm^{-1})	Modulus of elasticity($\times 10^{11}$) Dynes/ (cm^2)	Loss modulus (×10 dynes/(cm^2)
DP2	1	1485	0.070	0.035	0.043
	2	1552	0.069	0.126	0.601
	3	1582	0.037	0.730	15.759
	5	1706	0.034	1.182	90.561
	10	1813	0.027	1.452	575.652



Calculation:

Now determining the Ultrasonic velocity practically from table $\mathbf{V = f x \lambda}$
Put 1, 2, 3, 5, 10 MHz in
Velocity formula = 1 MHz X 0.6897x10^{-2} m/sec =0.6897 m/sec

Ultrasonic Velocity V = 6.897 m/sec for 1 MHZ, similarly we can calculate the velocities at different frequencies ranges, and then we will get the average velocity of all frequencies from the tabular values.

Results & Discussions

Tabular forms shows that the data on Acoustic and elastic parameters of normal human blood and its constituents. Those graphs are varying between Frequencies at different ranges and absorption coefficients of normal human blood of plasma and erythrocytes are given in tables. This study demonstrates the data on ultrasonic velocity of plasma by using of ultrasonic interferometer with low and high frequency ranges 1-10MHZ in liquids, One can measure the Biophysical aspects of Normal and Diabetes mellitus of plasma in the presence of acoustic resonance which gives rise to an electrical reaction on generator during the quartz plate and anode current shows maximum. It is an evidence that if glucose concentration is increases then coefficient of viscosity, maximum velocity decreases. Viscosity of blood is known to increase with increase in Hematocrit due to increased friction between successive layers of blood viscosity are the concentrations and type of proteins ,mainly fibrinogen in the plasma.

Conclusion:

This chapter is concerned with the results on bio physical properties and acoustic, elastic and ultrasonic parameters of plasma and erythrocytes are studied for the present Investigation. The Results are presented in the tables. The figures are presented in this chapter, which are represented by the graphs of different parameters, showing the relation between different parameters. In a survey of author‘s scientific investigations in the field ultrasound velocity measurements in electrolyte in various liquid system is presented successfully. One may conclude gives the result very accurate way in developing Bio chemistry and Pathological division.

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